

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

SURVIVAL FACTORS GROUP CHAIRMAN'S ADDENDUM #2

February 11, 2014

I. ACCIDENT

Operator	:	Asiana Airlines
Airplane	:	Boeing 777-200ER [HL7742]
Location	:	San Francisco, CA
Date	:	July 6, 2013
Time	:	1128 Pacific daylight time (PDT) ¹
NTSB #	:	DCA13MA120

II. SURVIVAL FACTORS GROUP

Group Chairman	:	Jason T. Fedok National Transportation Safety Board Washington, DC
Member	:	Emily Gibson National Transportation Safety Board Washington, DC
Member	:	Dr. Mary Pat McKay National Transportation Safety Board Washington, DC
Member	:	Peter Wentz National Transportation Safety Board Washington, DC
Member	:	Dr. Charles DeJohn Federal Aviation Administration Oklahoma City, OK
Member	:	Misty Sanchez Federal Aviation Administration Oklahoma City, OK

¹ All times are reported in local time unless otherwise noted.

III. SUMMARY

On July 6, 2013 at 11:28 am Pacific daylight time, a Boeing 777, registration HL7742, operated by Asiana Airlines as flight 214, struck the seawall short of runway 28L at San Francisco International Airport. The airplane was destroyed by impact forces and fire. Three of the 291 passengers were fatally injured. The flight was a regularly scheduled passenger flight from Incheon International Airport, Seoul, Korea, and was operated under the provisions of *14 Code of Federal Regulations Part 129*. Visual meteorological conditions prevailed at the time of the accident.

IV. DETAILS OF THE INVESTIGATION

1.0 Identification of Injured Occupants

In the days following the accident, the NTSB's Office of Transportation Disaster Assistance compiled a list of injured passengers and crew who visited local hospitals. The information came from the following sources: Asiana Airlines' flight 214 passenger manifest, the Federal Bureau of Investigation's Airport Liaison Agent for the San Francisco airport, the Department of Homeland Security's Investigations Directorate, United Airlines, the American Red Cross - Bay Area Chapter, Virgin America, Asiana Airlines (via Patton Boggs LLP), and the San Francisco Fire Department. The NTSB also issued subpoenas to area hospitals where occupants were known to have been transported to verify the information that had been received from these sources.

The compiled information about occupants who received local treatment was then used to subpoena medical records as described below.² No information was collected on any occupants who may have sought medical care outside the local area or who did not report injuries to the above sources.

2.0 Medical Records

For each identified individual, the NTSB subpoenaed the following items from the hospitals where treatment occurred:

- (1) Complete emergency department records (physician and nursing notes, medication administration record, procedural notes, radiology readings, laboratory results);
- (2) If admitted, the admission note, any physician transfer notes, final radiology reports, any operation notes, and the discharge summary; and
- (3) For all patients the discharge or transfer instructions and billing records (to include coded information such as ICD-9,³ E&M,⁴ or CPT codes,⁵ but may exclude financial information).

² Medical information was also provided by Asiana Airlines for two flight crew members who were treated for their injuries in Korea.

³ ICD-9 refers to the International Classification of Disease, Version 9. These are the diagnostic codes used by hospitals to bill for healthcare in the United States.

⁴ E & M codes are a subset of CPT codes used to describe patient visits to healthcare providers for the purpose of billing for healthcare in the United States.

⁵ CPT codes refers to Current Procedural Terminology and is a trademark of the American Medical Association. These codes are provided to describe medical procedures and services for the purpose of billing for healthcare in the United States.

Hospitals provided a variety of typewritten, computerized, and handwritten documents in response to the NTSB subpoenas.

3.0 Demographic Data and Notes

The demographic data (age, sex, height, and weight) contained in attachment 1 of this addendum came from information provided by the hospitals. In some cases, the height and weight were noted to be estimates. The passengers' assigned seats were provided on the flight 214 passenger manifest and crew seating information was provided by Asiana Airlines. It should be noted that some of the occupants were known to have moved and were not seated in their assigned seats for landing; therefore, the exact location of each occupant for landing could not be determined.

4.0 Injury Description and Coding

The Abbreviated Injury Scale (AIS) was used to code the injury information. The AIS system provides a scientific coding method for identifying and describing injuries. Coders require specific training in using this method. A Survival Factors group member from the FAA, who was a trained AIS coder, oversaw the coding process used by the group. The most recent (2005/Update 2008) version of AIS was used to perform this coding. In addition to a specific, six digit code for each injury, the abbreviated injury scaling system applies an AIS severity score of 1 (minimal) to 6 (fatal) to each injury. Where there was insufficient information to determine the degree of injury an AIS severity score of 9 was recorded. [1]

For each of the involved patients, the group assigned AIS codes to each injury identified by the treating health care providers, as recorded in the medical records. In some cases, the patients complained of pain in areas where no injury was diagnosed. These were recorded but no AIS code was listed. Where there were discrepancies, the final radiology reading (if applicable) was used to determine presence or absence of injuries. In cases where the radiology reading used words like "possible" or "clinical correlation required," notes from the physician staff and their diagnoses were used to define whether or not the specific injury was present. Of note, no radiological images were obtained and no direct discussion with health care providers regarding specific injuries was carried out. In addition, AIS coding was only performed for occupants who survived long enough to have a full hospital evaluation of their injuries.

In some cases, occupants visited a hospital more than once in the immediate post-crash period. If these visits were related to injuries sustained in the accident, and were diagnosed in the first 7 days, those injuries were included in attachment 1 of this addendum.

Along with each AIS code and AIS severity score, a narrative description of each injury was provided in attachment 1 of this addendum. This information included any available specifics, such as left or right, upper or lower arm, and the loss of height quoted on the radiology reports of spinal fractures. It also included the narrative description of signs or symptoms that

could not be coded. Of note, a “cervical strain” is synonymous with a “whiplash” injury or a neck sprain. Attachment 2 of this addendum is a dataset containing the same information.⁶

5.0 Injury Classification

According to Title 49, Code of Federal Regulations, Section 830.2, serious injuries are defined as an injury which is sustained by a person in an accident and which:

- Requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received;
- Results in a fracture of any bone (except fractures of fingers, toes, or nose);
- Involves lacerations which cause severe hemorrhage, nerve, muscle, or tendon damage;
- Involves injury to any internal organ;
- Involves second or third-degree burns, or any burns affecting more than 5 percent of the body surface;

Non-injury diagnoses such as pre-existing co-morbid diseases (like high blood pressure or diabetes), complications of hospitalization (such as pneumonia, blood clots, or urinary tract infections), and psychological trauma were not included. A determination of level of severity according to the above criteria was made and was recorded as the “NTSB Classification” – fatal, serious, minor, or none. Overall, 194 occupants (183 passengers and 11 crew members) were received for treatment at local area hospitals after the accident. Six of those passengers were found to have no injuries and one passenger died 6 days after the accident. Additionally, two flight crew members were not treated locally but received treatment at a hospital in Korea beginning on July 14, 2013.

Injuries	Flight Crew	Cabin Crew	Passengers	Total
Fatal	0	0	3	3
Serious	1	8	40	49
Minor	2	2	134	138
None ⁷	1	2	114	117
Total	4	12	291	307

Table 1. NTSB injury table

As another measure of severity, an Injury Severity Score (ISS) was calculated for each of the 171 occupants whose injuries were AIS coded. The ISS predicts the likelihood of survival among traumatically injured and can be used to compare the severity of injury among individuals. In order to calculate the ISS, the AIS coded injuries are divided into six regions: 1) head/neck, 2) face, 3) chest, 4) abdominal and pelvic contents, 5) extremities and pelvic bones, and 6) external. Then, the ISS is calculated by adding together the squares of the maximum AIS (MAIS) scores for each of the three highest scoring body regions ($ISS = (MAIS_{regionA})^2 +$

⁶ The dataset in attachment 2 also contains additional information including the body region used to calculate the injury severity score.

⁷ Passengers and crew who were not transported to a hospital after the accident and did not report an injury to the NTSB were considered to have no injury. This total also included 6 passengers who were examined at a local hospital but found to have no injuries.

$(MAIS_{\text{regionB}})^2 + (MAIS_{\text{regionC}})^2$). The maximum survivable score is 75. [2] Injuries coded to a severity of 9, unknown severity, preclude the determination of an ISS. Injury severity scores are routinely divided into four groups: minor (ISS 1-8), moderate (ISS 9-15), severe (ISS 16-24), and very severe (ISS >25). [3]

Table 2 shows the grouping of Injury Severity Scores among the occupants with AIS coded injuries. Figure 1 diagrams each passenger's ISS scores into their assigned seats. In addition, the NTSB injury classification is color coded: black indicates a fatal injury, red indicates a serious injury, yellow indicates a minor injury, and white indicates no injury.

ISS Severity	Number of occupants	%
ISS not performed *	25	12.8
Minor (1-8)	148	75.5
Moderate (9-15)	14	7.1
Severe (16-24)	5	2.6
Very Severe (>25)	4	2.0
Total	196	100

*Not enough information to AIS code the injuries, or AIS injury score of 9. These include the two passengers who died at the scene.

Table 2. Injury Severity Scores (ISS)

Cabin	Available Seats	Passengers Assigned	Known to have visited local hospitals
A	24	21	11 (52.4%)
B	157	158 (one lap child)	86 (54.4%)
C	114	114	86 (75.4%)
Total			183

Table 3. Passenger injuries by cabin location

The greatest proportion of injured passengers was located in the aft cabin. As shown in figure 1, a greater proportion of occupants seated in C-zone suffered serious injuries than in other parts of the cabin. Twenty-two percent of the passengers of C-zone sustained serious injuries, while 9% of B-zone passengers, and only 1 of 21 A-zone passengers were seriously injured.

Among the serious injuries, there were a notable number of spinal injuries more serious than a sprain or strain.⁸ This group included fractures, ligamentous injuries diagnosed by MRI, epidural hematomas, and dislocations of the spine. Although there were 79 separate, significant spinal injuries among 28 occupants, all but two were neurologically intact (i.e. did not have spinal cord injury).⁹ Figure 2 shows the assigned seating location for passengers with spinal

⁸ There are three sections to the spine. The cervical spine begins at the base of the skull and includes 7 vertebrae. The thoracic spine follows and includes 12 vertebrae. The lumbar spine is at the bottom and includes 5 vertebrae. It attaches to the sacrum or back portion of the pelvic ring of bones.

⁹ Two of the flight attendants who were ejected out of the rear of the airplane suffered fracture-dislocations in the area at the bottom of the thoracic spine (T12-L1).

injuries. The most common spinal injury occurred in the thoracic spine. All seven occupants who had sternal fractures also had significant spine injuries as can be seen in table 4.

Seat	Total # Spinal injuries	Cervical	Thoracic	Lumbar	Sternal fracture
11C	6	4	2		X
12H	1		1		
26B	1			1	X
28G	1	1			
29D	6	2	3	1	
30E	4		4		X
30G	4		4		X
31H	3	1	2		
31J	9	3	6		
32B	1		1		
32H	2		1	1	
33H	4		4		
34B	2		2		
35H	1	1			
35J	1		1		
36K	2		2		
37B	1			1	
38A	4		4		
38G	2		1	1	
39C	1			1	
40A	2		2		
40G	6	1	3	2	X
42A	1	1			
42D	4		3	1	X
1R	2			2	
L4	1			1	X
M4A	2		1*	1	
M4B	4	1	1*	2	
3R	1		1		
Total	80	15	50	15	7

*Fracture dislocation with spinal cord injury

Table 4: Spine injuries and sternal fractures

Two occupants suffered skull fractures, assigned to seats 11C and 42A. The male occupant in 11C was diagnosed with a concussion without loss of consciousness while the female occupant assigned to 42A had multiple brain injuries and did not survive.

References:

1. AIS 2005 Update 2008. Association for the Advancement of Automotive Medicine, B., IL 2008.
2. Baker SP, O.N.B., Haddon W, et al., *The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care*. J Trauma, 1974. 14: p. 187-196.
3. American College of Surgeons. *National Trauma Data Bank 2013 Annual Report*. Accessed 2/3/2014. Available from: <http://www.facs.org/trauma/ntdb/pdf/ntdb-annual-report-2013.pdf>.

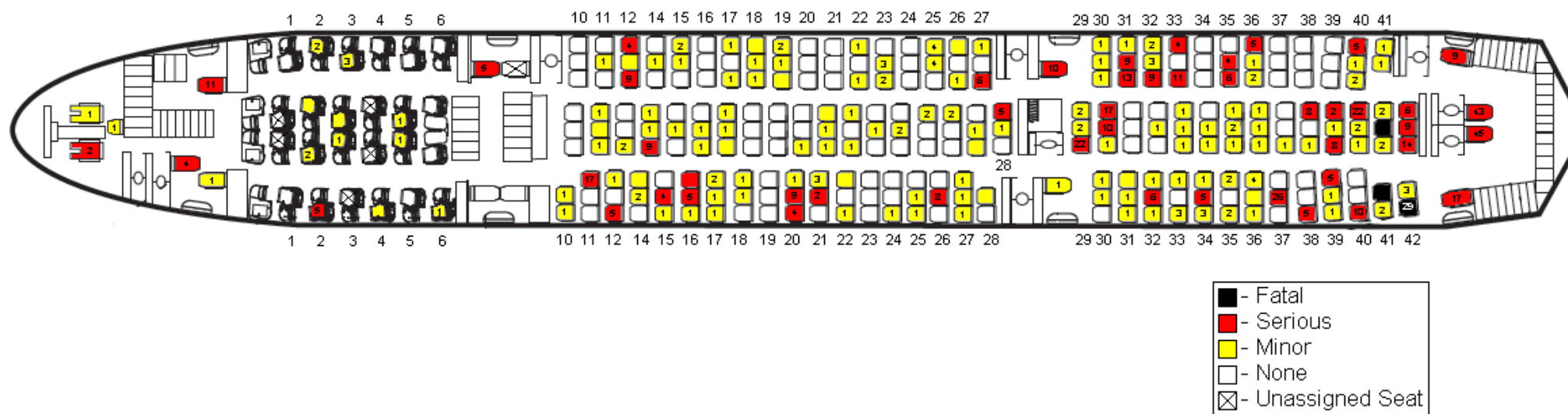


Figure 1. Injury classifications by assigned seat and crewmember position (including injury severity score).

* Note: Either seat 1E or 1F was occupied by an off duty crewmember who was uninjured.

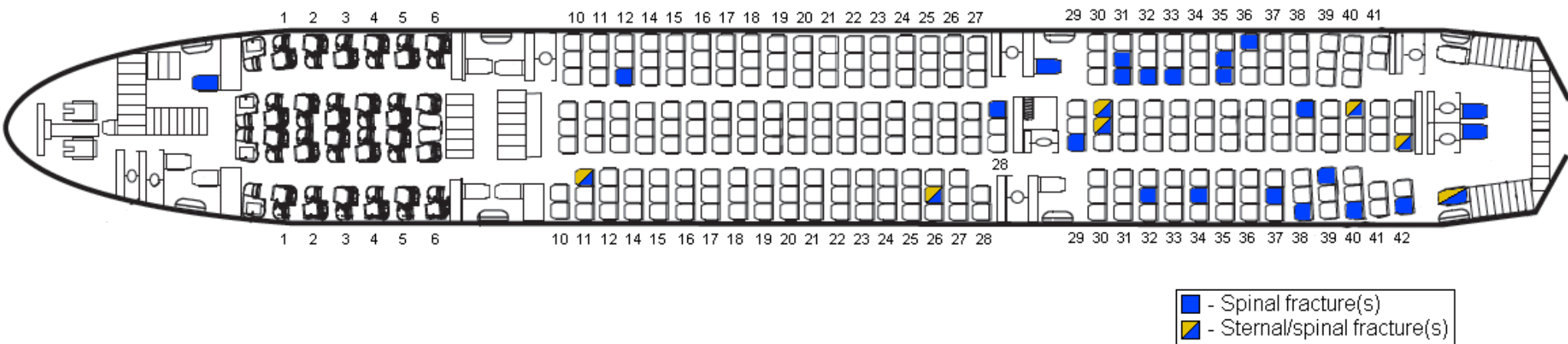


Figure 2. Assigned seats of occupants who sustained spinal and/or sternal fractures.